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XLVIII. *A Proposal for measuring the Attraction of some Hill in this Kingdom by Astronomical Observations. By the Rev. Nevil Maskelyne, B. D. F. R. S. and Astronomer Royal.*

Redde in the year 1772. **I**F the attraction of gravity be exerted, as Sir ISAAC NEWTON supposes, not only between the large bodies of the universe, but between the minutest particles of which these bodies are composed, or into which the mind can imagine them to be divided, acting universally according to that law, by which the force which carries on the celestial motions is regulated; namely, that the accelerative force of each particle of matter towards every other particle decreases as the squares of the distances increase, it will necessarily follow, that every hill must, by its attraction, alter the direction of gravitation in heavy bodies in its neighbourhood from what it would have been from the attraction of the earth alone, considered as bounded by a smooth and even surface. For, as the tendency of heavy bodies downwards perpendicular to the earth's surface is owing to the combined attraction of all the parts of the earth upon it, so a neighbouring mountain ought, though in a far less degree, to attract the heavy body towards its centre of attraction, which cannot be placed far from the middle of the mountain. Hence the plumb-line of a quadrant, or any other astronomical instrument, must be deflected from its proper situation by a small quantity

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towards the mountain; and the apparent altitudes of the stars, taken with the instrument, will be altered accordingly.

It will easily be acknowledged, that to find a sensible attraction of any hill from undoubted experiment would be a matter of no small curiosity, would greatly illustrate the general theory of gravity, and would make the universal gravitation of matter palpable, if I may so express myself, to every person, and fit to convince those who will yield their assent to nothing but downright experiment. Nor would its uses end here; as it would serve to give us a better idea of the total mass of the earth, and the proportional density of the matter near the surface compared with the mean density of the whole earth. The result of such an uncommon experiment, which I should hope would prove successful, would doubtless do honour to the nation where it was made, and the society which executed it.

Sir ISAAC NEWTON gives us the first hint of such an attempt, in his popular Treatise of the System of the World, where he remarks, "That a mountain of an hemispherical figure, three miles high and six broad, will not, by its attraction, draw the plumb-line two minutes out of the perpendicular." It will appear, by a very easy calculation, that such a mountain would attract the plumb-line $1' 18''$ from the perpendicular.

But the first attempt of this kind was made by the French Academicians, who measured three degrees of the meridian near Quito in Peru, and who endeavoured to find the effect of the attraction of Chimborazo, a
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mountain

mountain in that neighbourhood, which is elevated near four miles above the sea, though only about two miles above the general level of the province of Quito. By their observations of the altitudes of fixed stars taken with a quadrant of $2\frac{1}{2}$ feet radius, they found the quantity of 8" in favour of the attraction of the mountain, by a mean of their observations. This, indeed, was much less than they expected; but then it is to be considered, that their instrument was too small and imperfect for the purpose; and that they themselves were subject to great inconveniencies, being sheltered from the wind and weather by nothing but a common tent, and placed so high up the mountain as the boundary where the snow begins to lie unmelted all the year round. And indeed their observations, doubtless owing to these causes of error, differ greatly from one another, and are therefore insufficient to prove the reality of an attraction of the mountain Chimborazo, although the general result from them is in favour of it. Accordingly, one of the French gentlemen themselves, M. BOUGUER, who drew up the account of their experiment, expresses his wishes, that a like experiment might be made, to find the attraction of a mountain in France or England, where he thinks some might be found of sufficient bulk for the purpose. This experiment and these remarks were made in the year 1738, or above thirty years ago, yet I believe no similar experiment has ever been made in Europe.

I have made inquiries after a proper hill in this kingdom, for the trying of such a curious experiment, and

have been informed of two places in particular, extremely convenient for the purpose. The one is situated on the confines of Yorkshire and Lancashire; where, within the compass of twenty miles, are situated four very remarkable hills, called Pendle-hill, Pennygant, Ingleborough, and Whernside, which have been estimated to be from 600 to 750 yards elevated above the plane of the vales between them. By calculation on these *data*, it should follow, that the sum of the contrary attractions of Whernside, the largest of these hills, on the plumb-line placed half-way up the hill, would not be less than 30", and might amount to 46", which it is evident is a very considerable quantity, and sufficient to give us room to hope for a favourable and satisfactory success of the experiment. The other place pointed out for this purpose, is a valley two miles broad, between the hills Helwellin and Skidda, in Cumberland; which hills, according to a plan of them and the adjacent country, communicated by Mr. SMEATON, F.R.S. are elevated above 1000 yards above the intermediate valley. By a calculation made according to this plan, the sum of the contrary attractions of the plumb-line, placed alternately on the North-side of Helwellin and the South-side of Skidda, amounts to about 20", which is likewise a quantity large enough for the experiment. And although the density of the earth near the surface should be five times less than the mean density, as there is some reason to suspect, and the attractions, as here stated, should consequently be diminished in the proportion of five to one, still the sum of the contrary attractions of Whernside

side would be 6" or 9", and the sum of the contrary attractions of Helwellin and Skidda would be 4"; which quantities are not too small to be measured and demonstrated by an accurate zenith sector, such as that belonging to the Royal Society, which I made use of at St. Helena, would be, if the fault in the suspension of the plumb-line, which I there discovered, was corrected, in the manner suggested in the Philosophical Transactions, vol. LIV. p. 351.